

# Hydrogen Production R&D Highlights at the National Laboratories

K. Adjemian , R. Borup, A. Weber, K.  
Wipke, C. San Marchi, D. Anton, J.  
Holladay

October 2015



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operated by Battelle Energy Alliance

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**October 2015**

**Idaho National Laboratory  
Idaho Falls, Idaho 83415**

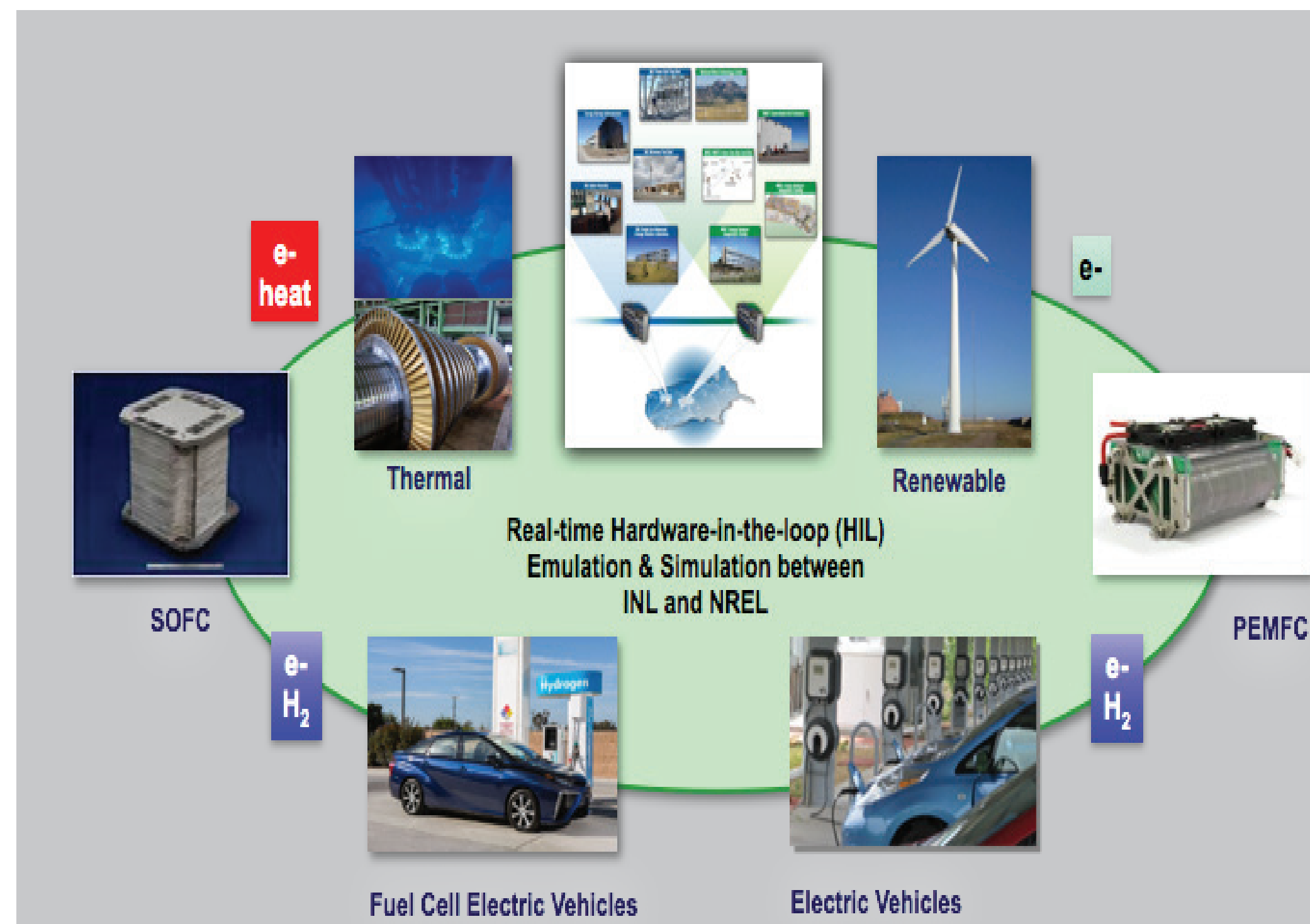
**<http://www.inl.gov>**

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# Hydrogen Production R&D Highlights at the National Laboratories

INL: K. Adjemian, LANL: R. Borup, LBNL.:  
A. Weber, NREL: K. Wipke, SNL: C. San Marchi,  
SRNL: D. Anton, PNNL: J. Holladay

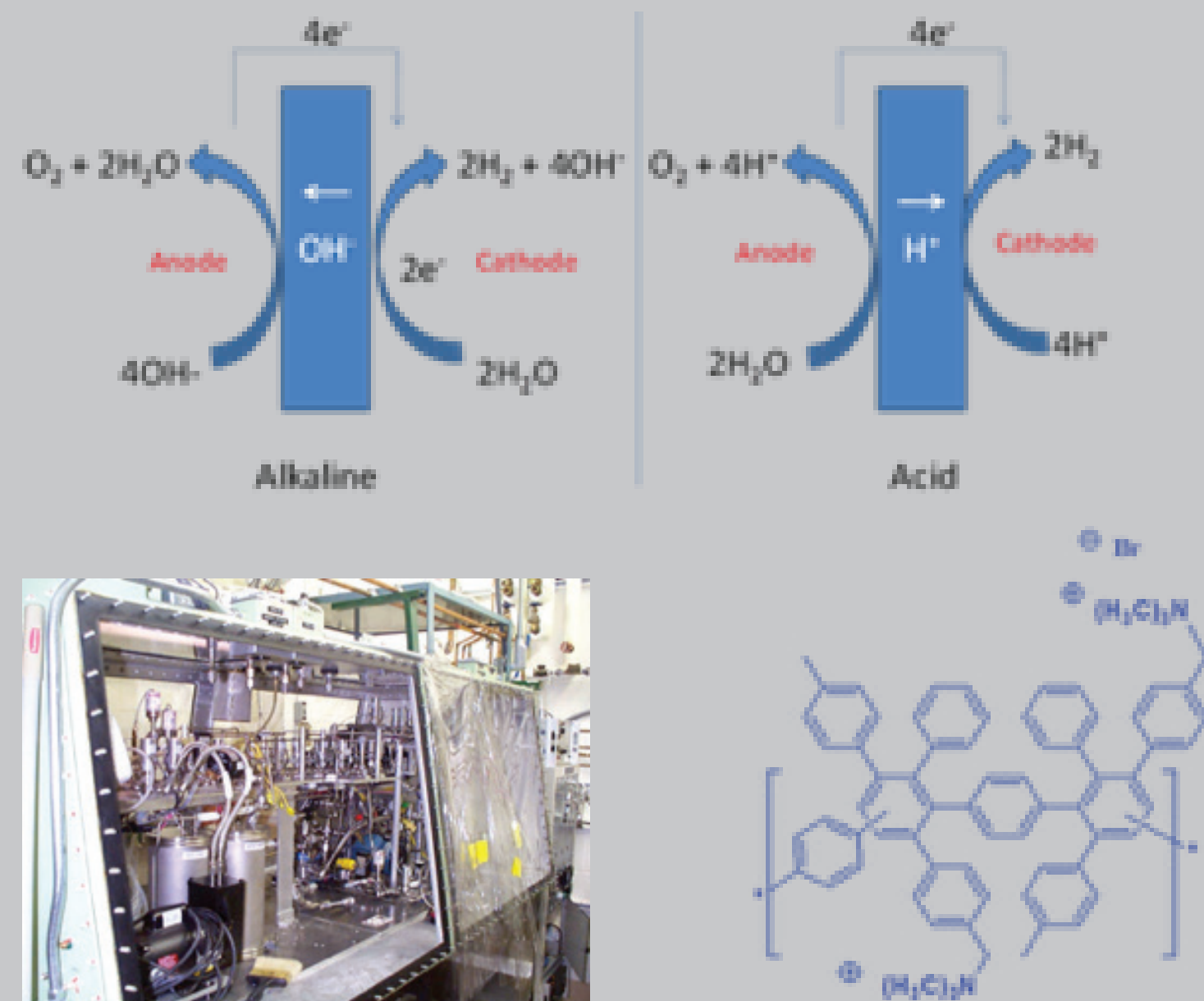


## Alkaline Electrolysis @ SNL & LANL

- The development of a stable hydrocarbon-based alkaline separator material for basic conditions would allow the use of non-precious metal catalysts and lead to lower system cost
- Polymers (ATM-PP) developed are stable under both high and low pH conditions

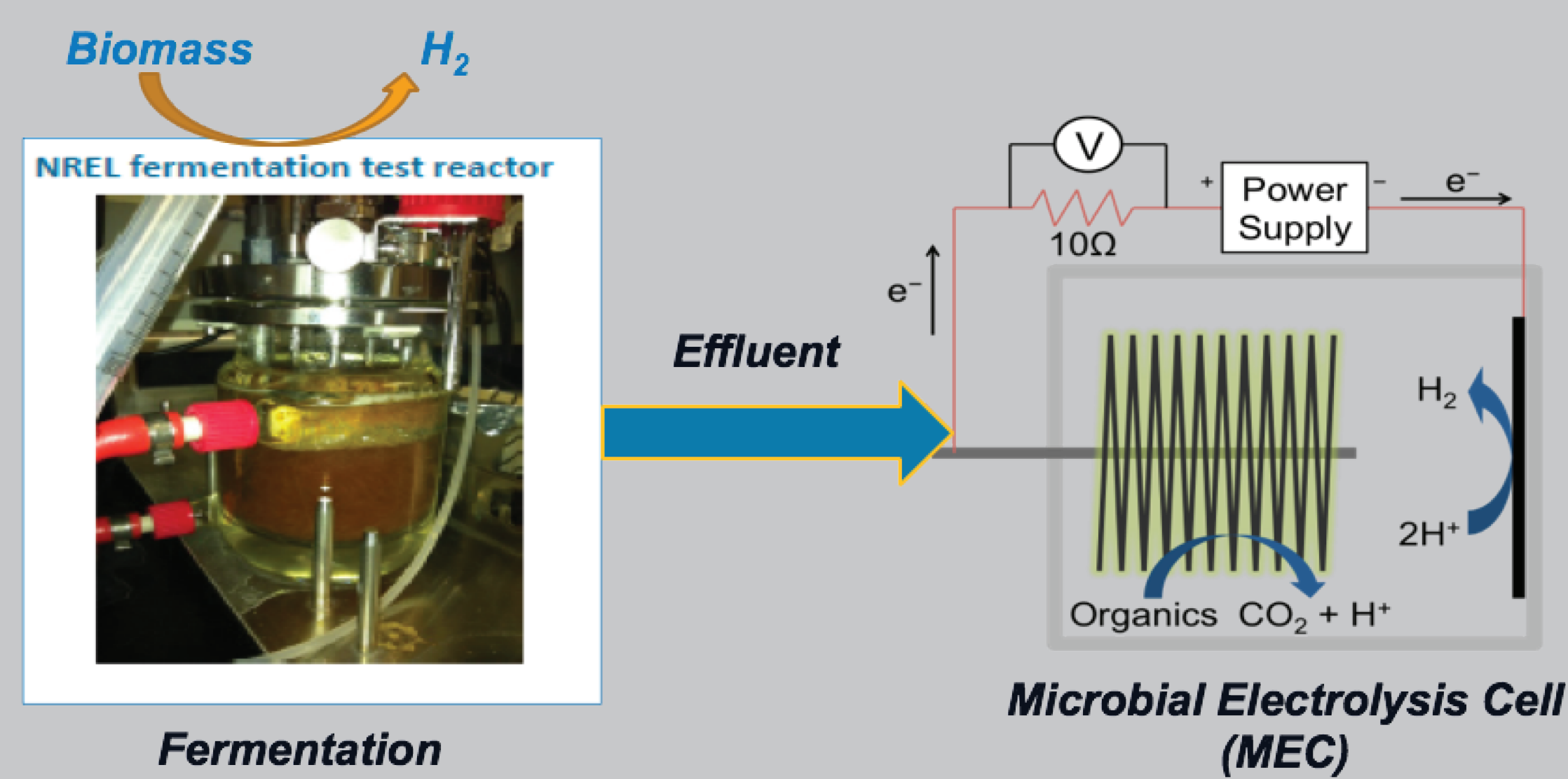
## High & Low Temperature Electrolysis @ LANL, INL & NREL

- Utilizing HTE and LTEs to stabilize the grid by using excess electricity to produce hydrogen which can then be used to fuel FCEVs or be electrochemically converted back to electricity
- LANL Tritium and water electrolysis system /experiments using high temperature ceramic proton conducting membranes



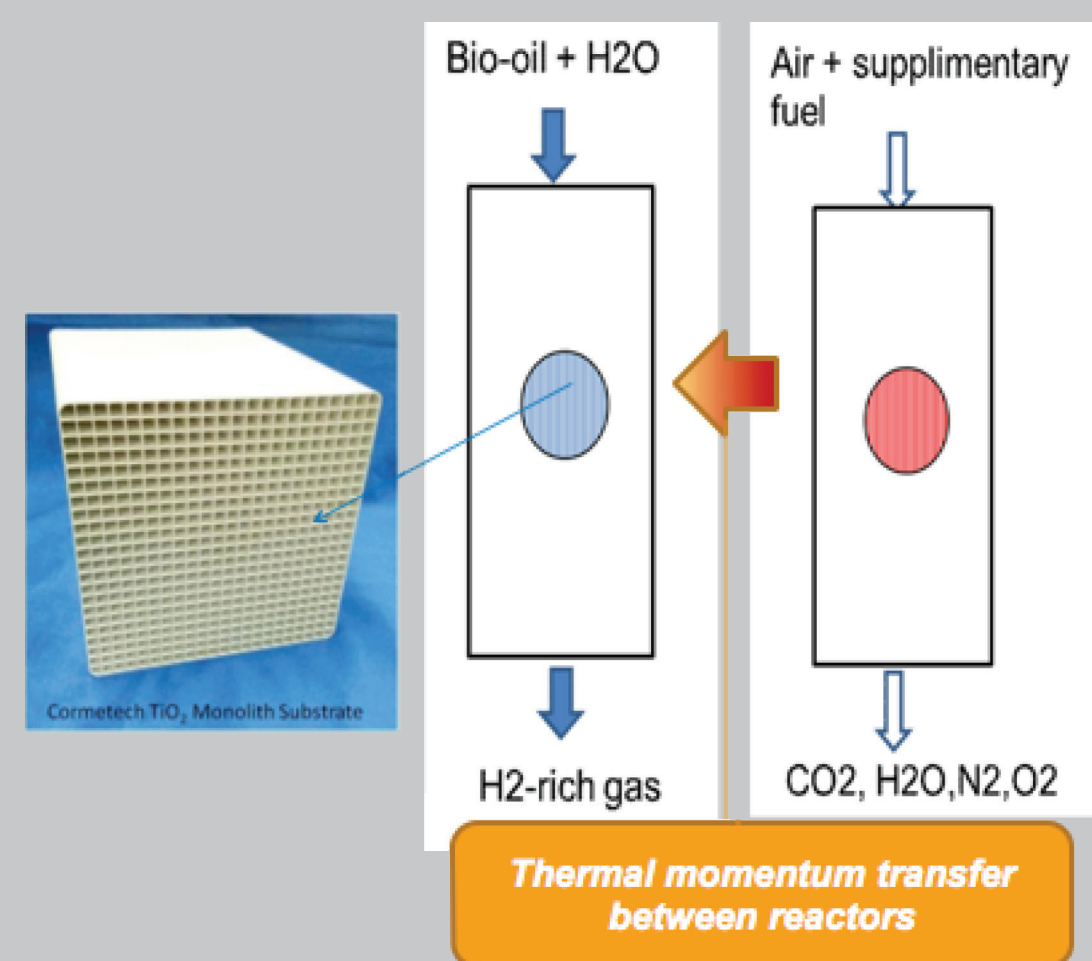
## Advanced Water Splitting

## Bio-Mass Conversion @ NREL



- Integrating bio-electrochemical technologies for H<sub>2</sub> production from biomass, aimed to increase H<sub>2</sub> molar yield and lower feedstock cost

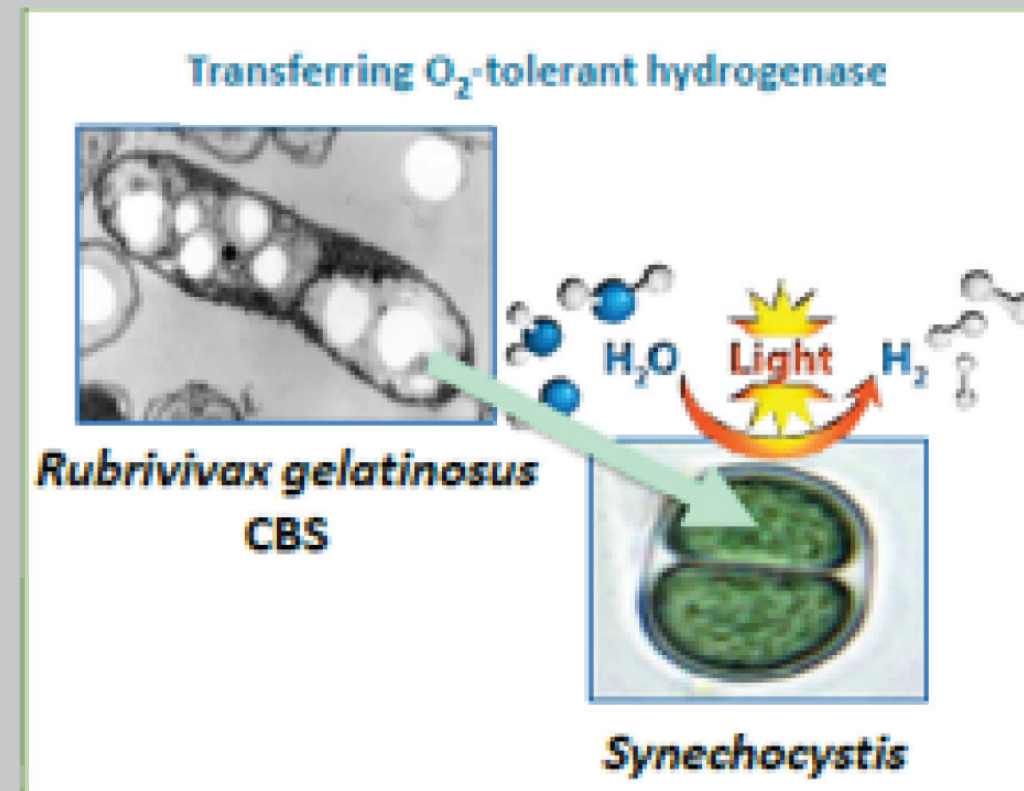
## Bio-Oil Steam Reforming @ PNNL



- Address inherent coking and catalyst deactivation challenges during steam-reforming of bio-oil by period regeneration
- Couple exothermic CO<sub>2</sub> carbonation with endothermic bio-oil reforming to improve net energy efficiency.

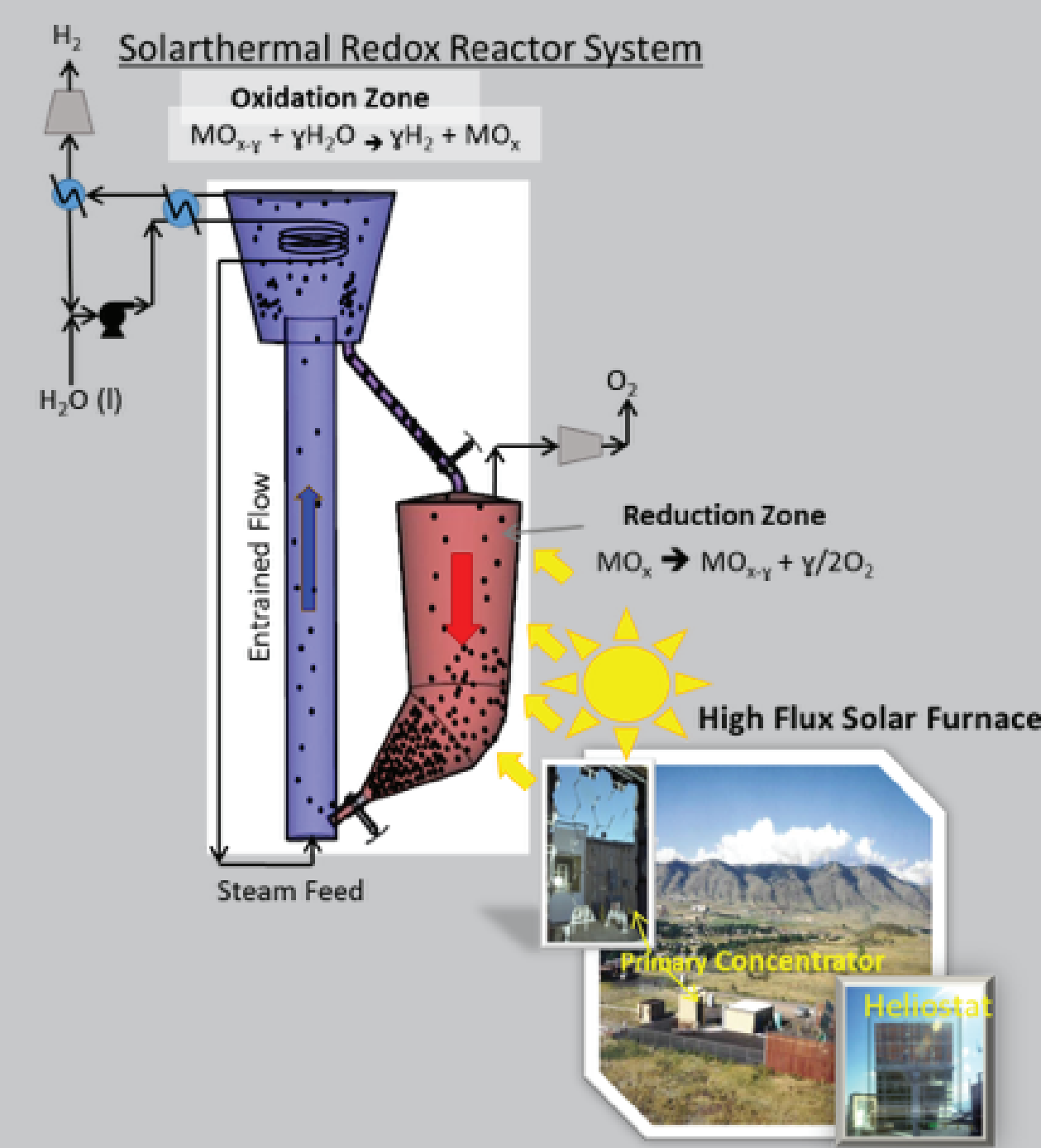
## Biological

## Photo-Biological @ NREL



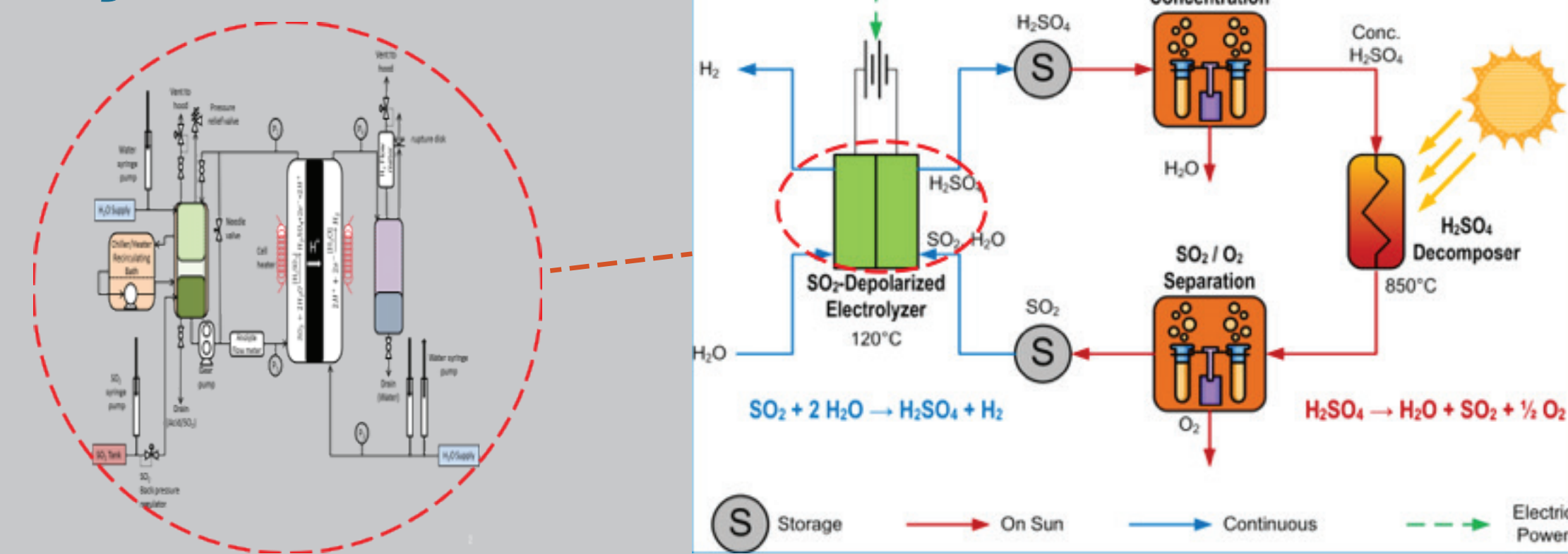
- O<sub>2</sub>-tolerant hydrogenase system development for sustained solar H<sub>2</sub> production in the cyanobacterium Synechocystis

## Flowing Particle Bed Solarthermal Redox Process @ NREL

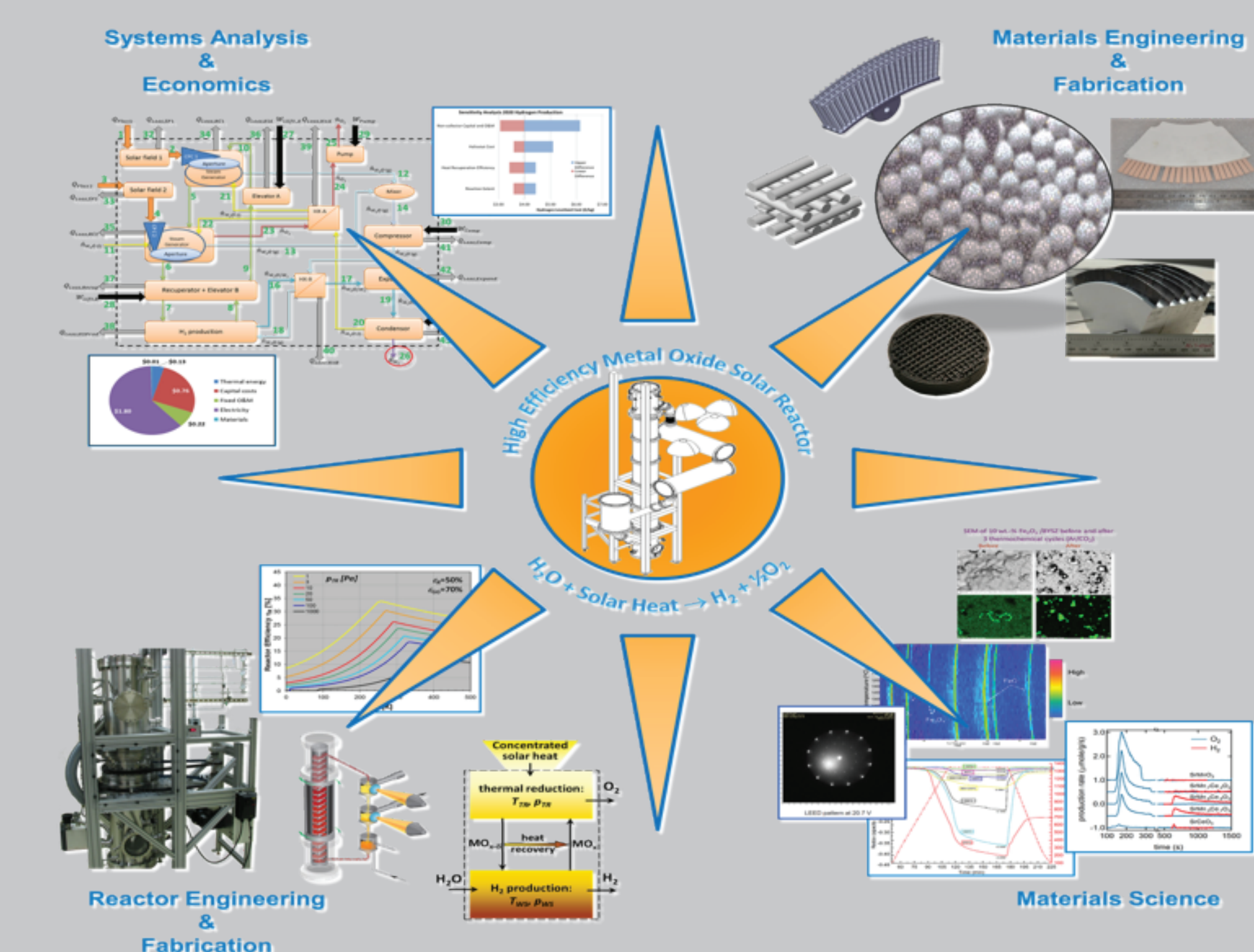


## Solar ThermoChemical (STCH)

## Hybrid Sulfur Thermo-Chemical Cycle @ SRNL

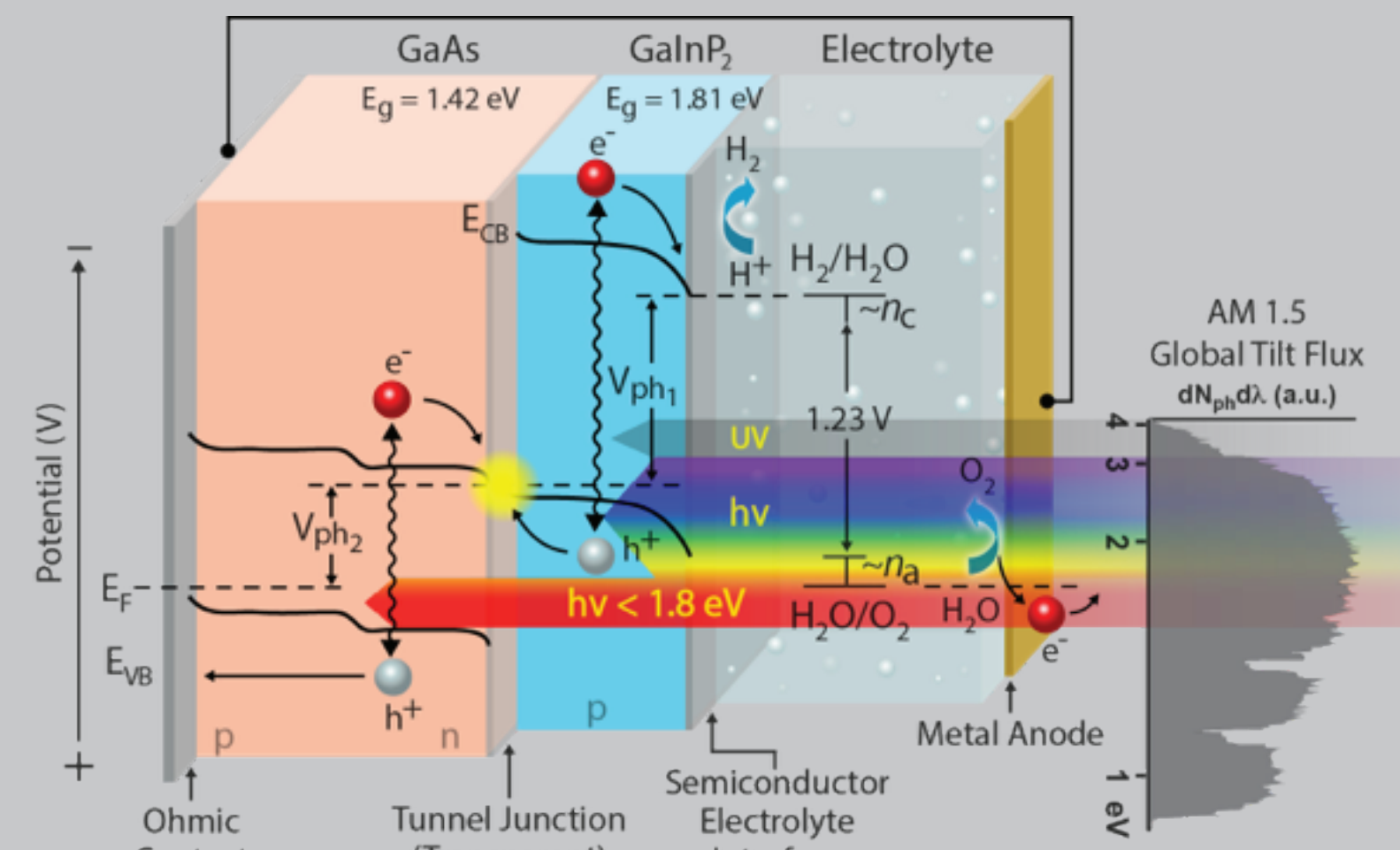


## Solar Thermochemical Hydrogen Production @ SNL



## High-Efficiency Tandem Absorbers for Economical Solar Hydrogen Production @ NREL

- World-record photoelectrochemical (PEC) water-splitting efficiency using monolithic tandem III-V semiconductor materials
- On-sun measurements with photo-reactors mounted on solar trackers at the solar radiation research laboratory where real-world performance can be compared with real-time research-quality measurements of solar radiation.



## Photo Electro-Chemical (PEC)

## Joint-Center for Artificial Photosynthesis @ LBNL

